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Lewis Research Center

Compressible Flow Computer Program for Gas Film Seals

A computer program, AREAX, has been developed which calculates the properties of compressible fluid flow with friction and area change. The program carries out a quasi-one-dimensional flow analysis which is valid for laminar and turbulent flows under both subsonic and choked flow conditions. The program was written to be applied to gas film seals.

Some shaft seals in advanced rotating machinery, such as in advanced aircraft turbine engines, may operate at higher speeds, temperatures, and pressures than the contacting shaft seals in current use. Because of these severe operating conditions, a positive face separation (no rubbing contact) is required for long life and reliability. However, seal-face deformation is very likely to occur.

These deformations may be caused by various distortions (thermal, centrifugal, pressure, etc.). Seal-face distortions become more pronounced under severe operating conditions and are usually detrimental to seal performance. Hence, prediction of these face deformation effects on gas-film-seal performance is of paramount importance. This computer program enables the prediction of gas-film-face-seal performance when face deformations and/or radial area change is significant. The analysis is especially useful for choked flow conditions.

Computer programs have proven useful in seal design where much of the physical information of interest is difficult to determine experimentally. AREAX should be used when the effects of seal-face distortions are desired and when the radial area change is significant.

The program must be supplied with the geometry of the seal, the gas properties, the sealed gas reservoir conditions, the constants for determining the variation of mean friction factor with Reynolds number, and certain logical variables which control output. Input and output can be in either the International System (SI) or the U.S. customary system of units.

In analyzing the flow across the seal, AREAX first reads the input data. It then analyzes the flow for each combination of film thickness and deformation angle. The program first solves the Mach number equation and determines the Mach number distribution across the seal face. AREAX then determines the distributions across the seal face of pressure, temperature, density, velocity, mean friction factor, Reynolds number, mass and volume flow rates, Knudsen number, seal opening force, center of pressure, and, where appropriate, rotational Reynolds number, variables associated with power dissipation, and axial film stiffness. When all the data for all the film thicknesses have been calculated, AREAX writes the output data with appropriate labels and headings.

Results obtained using AREAX showed excellent agreement with analytical solutions for pure radial viscous flow and for viscous flow with a small tilt of the sealing surfaces. Also, AREAX agreed with computer programs that analyze only parallel sealing surfaces.

Notes:

1. The program is written in FORTRAN IV for use on an IBM 7094 II/7044 direct couple computer.
2. Inquiries concerning this program should be directed to:

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